



Digital Management System of Library Books Based on Web Platform

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Abstract. In view of the slow response speed and single function of the library's book management system, this paper designs a library's digital management system based on the network platform. In the hardware part, t91sam9263 chip is used as the core, and the digital management system is established based on the web platform. In the software part, on the basis of dividing the grid space of digital management of books, the management mode of virtual space of books is designed by using virtualization technology. Introduce user interest indicators to recommend book resources personalized. The system test results show that in the face of high concurrent requests, the response time of the designed system is less than 300 ms, the error rate of book recommendation is less than 5%, and the performance is obviously improved.

Keywords: Web platform · Library · Book management · Digital system · Virtual space · User interest

1 Introduction

University library, as an auxiliary teaching unit in colleges and universities, mainly serves students, teachers and other administrative personnel working in colleges and universities, and is a comprehensive institution providing academic research services. Therefore, no matter in terms of collection or reader groups, it has obviously different characteristics from general social libraries [1]. Readers in colleges and universities have different needs for libraries due to various reasons, such as students' different majors, grades, curriculum arrangement, research directions and hobbies, teachers' different teaching courses, research fields and further studies, etc., and the requirements for library data management system are constantly improving. Today, with the rapid development of information technology, how to finish the work more efficiently and quickly has become people's primary goal. Traditional libraries occupy a large area, and books are widely distributed, so ordinary unfamiliar borrowers can't quickly find the books they need, which reduces readers' enthusiasm for acquiring knowledge to a certain extent and greatly reduces learning efficiency [2].

The construction of digital library management is a complex project, including how to implement the generic cabling system, what network technology to choose, and how to

realize the construction of hardware projects such as computer network communication. However, to realize the functions of digital library, the corresponding software system is also indispensable. More importantly, it is necessary to realize the functions of collection and classification, management and storage, reservation query, access rights and so on of digital resources in the library. Only in this way can we provide users with convenient, fast and comprehensive information services. This is a two-sided problem. On the one hand, it manages the user's management needs for the system, that is, the requirements for the collection and processing of information resources, the storage and release authority management, and on the other hand, it is the reader user's functional requirements when using information. To sum up, the key core and lifeline of digital library construction is to build a digital resource system, and the establishment of the digital resource system is the precondition for the library to realize digitalization. Because the construction of digital library involves the cooperation and assembly of multiple modules, the data volume of the overall system is large, and the response is often slow when users use it, so it is necessary to design a new digital library management system.

Nowadays, the university network has been popularized. Transplanting the library to the network can not only solve the problems existing in the traditional library, but also transfer the record link data of library books in the past to the database, and complete a large number of data processing operations with computers, simple and convenient operation, well-organized data classification and storage methods, which greatly reduce the workload of librarians and improve work efficiency. Although the digital electronic library is being built in an orderly way, there are still many digital libraries with constantly updated and changing user requirements, gathering and expanding network resources. For example, how to push users' corresponding information, how to quickly and accurately query users' demand information, how to reasonably mine users' information, how to provide diversified user services, how to communicate with users more personalized, and how to display the final execution results in a friendly interface are all issues that need to be seriously considered at this stage.

With the rapid development of Internet technology, Web 2.0 has played an important role in the network and is an indispensable part of people's information life. Web 2.0 pays attention to respect for all individuals, pays more attention to users' own knowledge and information, and at the same time, it is also an important core idea of Web 2.0 [4]. However, at present, the library management systems in different environments are different, especially how to share information in the library and how to interact effectively between readers and the library. WEB-based book management information system is a system that uses computer system to manage books ordering, borrowing, returning books and searching. Through this system, the efficiency of book management is greatly improved, and readers' borrowing, information query and other needs are facilitated, which has incomparable advantages over manual management. According to the above analysis, in order to meet the above requirements, aiming at the problems of imperfect functions, complicated operation, slow efficiency and large hardware resource occupation of the previous library management system, this paper will study and design a digital library book management system based on the web platform, and apply the system to the actual library book management work, so as to enhance the professionalism of

university library data service, improve service quality and service response efficiency, and ensure the needs of university library construction.

2 Hardware Design of Library Books Digital Management System Based on Web Platform

When designing the hardware part of the digital library books management system based on the web platform, the hardware part should meet the requirements of this paper's embedded design scheme. The overall architecture of the hardware part of the system is shown in Fig. 1.

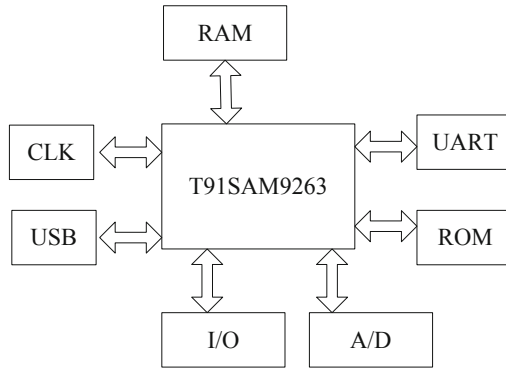


Fig. 1. Hardware architecture of library books digital management system

The core control of the hardware part of the library books digitization management system designed in this paper is the T91SAM9263 chip based on ARM core as the hardware control processor of the system. The chip has the highest clock frequency of 266 MHz, and has 2 USB OTG interfaces, extensible Ethernet interfaces, 4 UART, 2 CAN channels, 2 SSP controllers, 1 SPI interface, 3 I2C interfaces, 2 input and 2 output I2S interfaces and 8 channels of 12-bit ADC. The ARM has two stack pointers, but only one of them can be used at a time. The main stack pointer (MSP) is the stack pointer used after reset, which is used for system kernel and exception handling. The process stack pointer (PSP) is used by application code written by users [5]. The hardware part of the system is externally connected with a 2 Mbits ferroelectric memory, the model is FM25CL64B-GTR, and the interface is standard SPI interface. Ferroelectric memory has the advantages of RAM and ROM, fast reading and writing speed and nonvolatile characteristics. In this design, there are two external memories, one external memory is used to load programs, and the system is started from this memory when it is reset [6]. Another piece of external memory saves the data backed up by hardware checkpoints, and restores the saved data to the system when the system is powered on next time.

In the main memory, this system chooses SDRAM as the main memory, which is mainly based on its advantages of fast processing speed and low price. At the same time, this system occupies a large amount of memory when running the GUI, so SDRAM

with large capacity should be used as the main memory of the system. Based on this, this system selects the chip MT48LC16M16A2 produced by MICRON Company, and this system uses two pieces of SDRAM with a total size of 64M as the main memory.

An idle register address in T91SAM9263 chip serves as the communication channel between SCORE and HSCORE. SCORE compiles and generates the “.HEX” file in KEIL as the ROM initialization file of CPU. HSCORE is designed by Verilog HDL, including command receiving and decoding module, task management module, delay management module, timer module, semaphore management module, mutually exclusive semaphore management module, edge detection module and task arbitration module. SFR bus has 8-bit address space, some of which are occupied by internal modules of T91SAM9263, such as timer and serial port, etc., which are defined and used as shown in Table 1.

Table 1. SFR address representation

Port				
P0	P1	P2	P3	P4
80h(1)	90h(1)	93h-97h	9Ah-9Fh	A0h(1)-A7h
9Ah-AFh	B0h(1)-B7h	B9h-BFh	C2h-C7h	C9h
CEh	CFh	D1h-D7h	D9h	DAh-DFh
E1h-E7h	E9h	EAh-EFh	F1h-F7h	F9h-FFh

In order to reduce the time of task switching and improve the way of interrupt triggering task switching, a multi-user register group working scheme is designed. The logic unit of FPGA is used to configure a set of RO-R7 registers, PSW (program status word), ACC (accumulator), B (one register), DPL (lower 8 bits of data pointer register), DPH (upper 8 bits of data pointer register) and stack space for each task. Each register group takes the highest priority of the task as chip selection, and the task switching can be realized without frequently moving data. In the auxiliary memory, the auxiliary memory is used to store a large amount of program code or information, so the size and price of the auxiliary memory become the decisive factors in choosing it. NANDFLASH has become the first choice for most embedded systems because of its large capacity and low price per unit capacity. In this design, the 8-8bit NANDFLASH memory K9F1208UOB is selected as the auxiliary memory of this system, and the size of K9F1208UOB is 64M, which can fully meet the requirements of this system.

In this design, the chip ISP1362 is selected as the USB host controller, and the interface between the ARM control chip and ISP1362 is designed. As the peripheral of this system, ISP1362 is mounted on the SFR system bus of T91SAM9263, and the peripheral address 9Ah is assigned to it. When reading the peripheral data with address 9A, first set the data on the `sfr_addr` address bus to 9A, so that the chip select signal `sfr_cs_9A` is valid. When the read control bus `sfr_rd` is valid, read the data into the data bus `sfr_data_in`, and then complete a data reading operation.

When the hardware part communicates with the upper computer of the software part of the library book digital management system, it communicates through SPI bus. The

external RESET of the hardware part is to reset the chip by pulling the reset pin of the chip to low level. The reset signal can't be removed immediately after it appears. The reset signal can only be removed when the crystal oscillator runs stably and the XTAL1 pin of T91SAM9263 meets the specified clock signal. The RESET pin of T91SAM9263 is Schmidt trigger pin with an extra interference filter. The filter can filter out very short pulse signals, so that the processor will not be accidentally reset by interference pulses or reset many times by unstable reset signals.

Under the hardware framework of the library books digitization management system designed above, the effective management of university library books digitization is realized in the system software part combined with the web platform.

3 Software Design of Library Books Digital Management System Based on Web Platform

3.1 Building the Web Platform Architecture of Library Books Digital Management System

The core concepts of Web 2.0 are interaction, sharing and relationship. In this paper, B/S architecture is used to design the software structure of library books digital management system. In B/S architecture, the server is an important part, which integrates business logic. Users mainly use browsers to send requests to the server on the WEB side. The WEB transmits the requests to the server through the back-end modules and users' demands. The server processes the data accordingly and returns the final results to the users. The final results will be presented to the users in the form of hypertext markup language, which may contain some scripting languages. B/S architecture is mainly based on browser and server architecture. Users send their own requirements to the server through the browser, and the server returns the results to users through a series of processing. Compared with C/S, B/S does not need to maintain the client or update the client from time to time, which reduces the specificity of the client. Figure 2 is the functional structure diagram of the library book digital management system software based on web platform.

The system adopts a three-tier architecture model, including client node, server node and database node. The client is mainly IE browser, which requires IE 8.0 and above. It is mainly responsible for communicating with the server and realizing data interaction. In order to reduce the pressure and security of the server, this system adds a series of additional functions of authority logic judgment and data verification to the client. Tomcat is installed in the server, which deploys the main code of the system and interacts with the client and database nodes at the same time, mainly including system authority verification, data access, business logic processing, etc. The database node adopts SQL Server 2008, which mainly stores a large amount of data in the system and provides data support for the server. The running environment of the system is the local area network on campus and the external network of the school. Browser is responsible for the input, management and output of system data, and Server is responsible for the storage, access and processing of data.

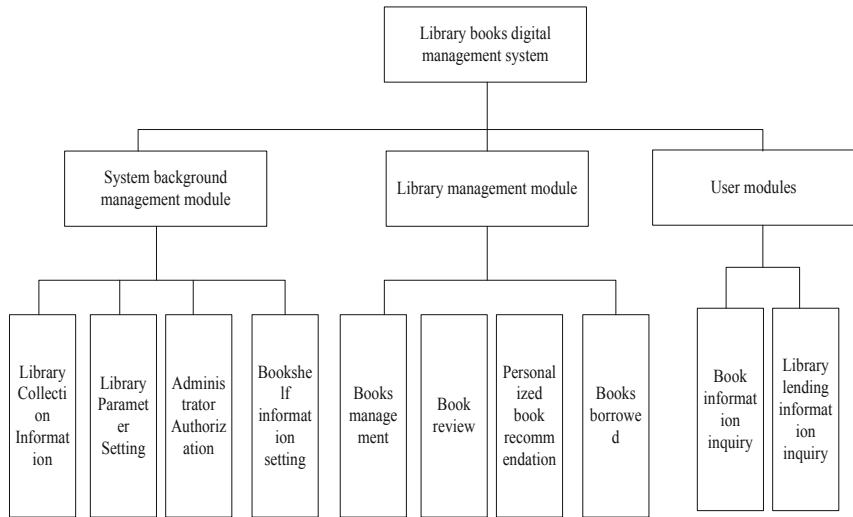


Fig. 2. Functional structure diagram of digital management of books

3.2 Grid Division of Virtual Space in Library Digital Management

With the expansion of systematic book resources, it is easy to cause confusion if all resources are managed together. At this time, by dividing the total resources into small subsets, the small subsets will not influence each other, and better results will be achieved. Virtual grid organically combines a series of basic functional modules to work together to ensure the efficient operation of the system and provide high-quality services to users. The functions required by the grid environment include management hierarchy, information service, communication service, security and authorization, distributed file system, system state and fault tolerance, resource management and scheduling, programming tools, user interface and so on. The basic functional modules for managing the virtual space grid of books are shown in Fig. 3.

In the same host, virtual machines and virtual machines are in a resource competition relationship. By setting the resource allocation of virtual machines, some virtual machines can be prevented from occupying most of the load while some virtual machines have no resources available, which affects the computing space in book management and scheduling. Resource allocation settings (share, reservation and limit) are used to determine the amount of CPU and memory resources provided to the virtual machine. In the grid, there are three entities: resource requester, resource intermediary and resource provider. The resource intermediary is the resource manager, and sometimes the resource provider is the resource itself. According to the different information flow paths in the process of book management, there are three forms of book management system. This design uses triangle structure to divide the virtual grid, that is, users make a request to the book resource manager, and the resource manager searches for suitable resources for users and drives resources to work, and at the same time, tells the resources in what form and address to return the service result to the requester, and tells the resource requester

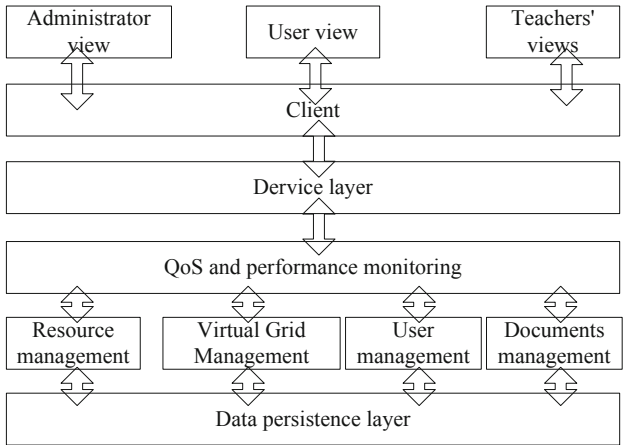


Fig. 3. Virtual space grid structure of digital management of library books

the service result according to the message provided by the manager after the service [7].

Grid users interact with the grid through user interface, such as resource request, result return and other functions. After selecting a resource, the grid provides the resource to users and manages the resource, which requires the function of resource management. In the process of providing services, the grid needs to transmit the grid data to the required nodes, and the job management module provides the report function of job operation. The cost and time for users to use resources are realized by the user accounting and management module. The whole process of grid users using the grid needs communication and security guarantee QoS guarantee.

Under the virtual grid, the system software can be divided into four layers: portal layer, service layer, logical function layer and data persistence layer. The portal layer is mainly responsible for the interaction with grid users, and provides users with various services related to virtual organization through the service layer providing clients, thus shielding the complexity of the underlying services for users. The service layer is mainly responsible for encapsulating the functions of each module in the logical layer according to the management policy, and providing services to grid service systems and grid users in the form of Web Service. The logic layer is mainly responsible for providing the upper layer with basic logic functions including users, resources, voucher management, etc. through the support of the data persistence layer. The data persistence layer communicates with the underlying database, providing data persistence support for the realization of upper logic functions and shielding the underlying complex data access operations.

3.3 Book Virtual Space Management Mode Setting

Virtualization technology can effectively reduce the waste of computing resources caused by deploying a large number of servers. In virtualization technology, multiple virtual machines can share a physical machine, but they are completely isolated from each other as if they are running multiple physical machines. Different operating systems

and applications can be run on these virtual machines, and they do not interfere with each other. Moreover, the virtual machine is completely independent of the underlying physical hardware, which enables users to migrate the virtual machine from one physical machine to another without changing the device driver, operating system and application program. In the virtual grid, the concept of virtual organization is introduced to establish a flexible and safe resource sharing and management mode. At the same time, single sign-on and controllable cross-domain resource sharing are realized through certificate issuance and detection, so as to provide users with a unified and safe way to use grid resources and provide the system with simple and effective user and resource management services. In this paper, the book resource sharing structure of distributed library based on Web technology is the core part of digital management of university books. The servers are completely peer-to-peer P2P mode, but it is not required that the use of university book resources in grid system is also P2P mode. The users in the virtual organization of regional university book resources management are mainly university members, and share setting, reservation setting and restriction setting are required when corresponding users request book resources scheduling. The share values of virtual machines can be set to high, normal and low. When set to high, each CPU has 2000 shares, and the configured virtual memory has 20 shares per megabyte. When set to normal, each CPU has 1000 shares, and the configured virtual memory has 10 shares per megabyte; When set to low, each CPU has 500 shares, and the configured virtual memory has 5 shares per megabyte. In this system, the CPU resource reservation of the virtual machine is set to 1 GHz, and the memory resource reservation is 1 GB, which can be reserved when the virtual machine is created. After the virtual machine is created, the resource reservation of the virtual machine can also be reset by reconfiguration.

In the grid environment, any virtual organization can be regarded as an entity. According to the characteristics of resource organization and function, its functions are encapsulated into related services. For users, virtual organization members are not only a resource entity, but also a service entity. According to the commonness and difference of service functions of virtual organizations, the common services are integrated in the network, and the different services are interconnected, thus forming the resource sharing service model of virtual organizations. The resources of this system are all placed in the data center of the library, and the resources are divided by clusters, in which virtual machines can migrate in the hosts in the clusters. The problem to be solved in resource scheduling is to balance the load among hosts, that is, to transfer the load pressure of the host with heavy load to that with light load.

D is the wide-area dispatching service center, $D = \{d_1, d_2, \dots, d_n\}$, d_i is the resource management and dispatching center. Following the grid resource allocation management (GRAM) of OGSA, D gathers all the basic service information of d_i , including d_i 's address, service cost, service task application amount, etc., and is responsible for the dynamic grid service management and coordination of each d_i . The specific resource sharing and scheduling process is as follows:

Firstly, d_i inquire all the information of the books in the current collection from the local task management and dispatching service center of D Middle School or other places, and select the best book scheme according to the inquiry results, and then send a dispatching request directly to the local task management and dispatching service

center to which the tasks will be transferred. d_i . After receiving the reply of consent, the task will be scheduled, otherwise, it will apply to other local task management and scheduling service centers again until the book borrowing or information update service operation is completed. In this way, through the coordination and sharing of resources among virtual organizations, the collaborative lending management service for library books is realized.

3.4 Implementation of Book Resource Management Recommendation

This design constructs the following recommendation model of university book resource scheduling, in which the book resource collection is defined as $R = \{r_1, r_2, \dots, r_n\}$, assuming that there are $R = \{r_1, r_2, \dots, r_n\}$ kinds of resources, r_i refers to the i th kind of resources, and its quantity is recorded as NR_i units. The total quantity of all resources is recorded as N , $N = \sum_{i=1} NR_i$. The user set is defined as $S = \{s_1, s_2, \dots, s_m\}$, and s_j refers to the j th user. Assuming that there is a M number of users, M is always greater than N . When recommending student books, users' needs and interests should be taken into account. Therefore, this design uses the user interest model based on BTVSM to reflect users' interest in book resources more truly. Users' interests will change with the passage of time, some topics that users were originally interested in will be gradually forgotten, and new topics of interest will gradually emerge. In order to reflect users' interests more truly, the user interest model is represented by the vector space model (BTVSM) based on background and tense. That is to say, subjects and sections are introduced into the model as background constraints, and interest weight function $W_n(t_n)$ based on temporal changes is introduced into vector space to calculate the attenuation and update of user interest weight. At a certain time t , the user interest model is expressed as:

$$IS = \{A, G, K\} \tag{1}$$

$$K = \{(k_1, w(t_1)), (k_2, w(t_2)), \dots, (k_n, w(t_n))\} \tag{2}$$

Among them, A represents the classified collection of books in university library; G indicates the grade of college students; K represent that keyword vector space of user's inter, and k_n is the n keyword describing interest; t_n represents the time set of each submission of keywords, and $w(t_n)$ is the weight function of keywords k_n with respect to time. For the attenuation and update of users' interests, the mechanism based on time window is used to calculate, that is, within a certain time window, if keywords are submitted, the weight will be increased; Otherwise, the weight is attenuated.

Assumptions:

1. Every time keyword k_n is submitted in each time window ΔT , the interest weight is increased by q units;
2. If keyword k_n is not submitted in each time window ΔT , the interest weight attenuation unit p ; Then, at a certain time t , the interest weight function of keyword k_n is expressed as:

$$w(t_n) = \begin{cases} [f((t_n + i\Delta T - \Delta T)) \cdot q - \xi p], & w(t_n) > 0 \\ 0, & else \end{cases} \tag{3}$$

where, f indicates the number of time windows in the time period. There may be multiple requesters for each resource. Suppose that for book resource R_i , if there are y units left unused, then an allocation queue is set up for resource R_i . When user s_j requests resource R_i , the user enters the allocation queue of resource R_i . It is easy for people to follow the principle of first come, first served. The user who requests earlier is at the top of the queue and has the right to use resource R_i first. In other words, users who wait longer have the right to use resources first. F_j indicates that the user j obtains the benefits generated by the resource combination R_i in the resource allocation. F represents the collection of book resources obtained by all users. Then the objective function of integer linear programming recommended by library books is as follows:

$$Q = \max \sum \sum F_j(R_i)x_{js} \quad (4)$$

$$\begin{aligned} \text{st. } & \sum x_{js} \leq 1 \\ & R_i \in R \end{aligned} \quad (5)$$

where, x_{js} indicates whether the user has been assigned books R_i , and if so, the value is 1, otherwise, it is 0. According to the actual storage situation of the corresponding books in the library, solve the above model and get the personalized recommendation scheme of books. When using the system, students can choose to borrow books according to the recommended results obtained by the system. Transplanting the software function part designed above to realize library book management to the system hardware part, that is, completing the design of library book digital management system based on web platform.

4 System Test

The function test of the system that has been designed above is the basis to ensure that the designed system can effectively and stably exert its functions in the actual use process. The following is the test content of the library books digital management system based on the web platform.

4.1 Test Content and Preparation

After the overall design of the system is completed, it is necessary to test the system to ensure that the online book management system can meet the design requirements. In this paper, the test of the library books digital management system based on web platform is to carry out various assembly tests and function confirmation tests on the whole system. After completing the test function of the system, it is necessary to test the single running effectiveness of the network, peripherals, software and hardware equipment of the system and the running effectiveness of this single element in the complex environment, which is the main test content of this test. The testing work of this design adheres to the principle of comprehensive testing, and it is planned to conduct an overall test on the

whole product, which serves as the full coverage of the system functions in the test range, to check whether the design system can perfectly realize the designed functions of the design function design part, and to screen out some functions that are found to be inconsistent or contradictory in some tests, and make targeted revision and correction.

As an important part of software development, system testing can ensure that it has a positive impact on the effective development of the project only through repeated testing of the system. Based on this, this section tests the function and performance of the library books digital management system designed by this design, so as to analyze its feasibility in practical application, so as to avoid problems in its later investment and use. In this system test, the digital management system of library books based on web platform designed in this paper is compared with the library management system based on WeChat platform database and the library management system based on mobile AR. Evaluate the performance of the system by comparing the stress test of the system with the personalized recommendation effect of books.

4.2 Test Result

Firstly, the system hardware connection and basic operation function response designed in this paper are tested. After testing, the hardware part of the system designed in this paper is connected normally, and it can respond to the user’s requests for books borrowing, administrators adding books information and other operations, and runs well as a whole.

The performance of the three systems is tested under different concurrency of book access requests, and the test results are shown in Table 2 below.

Table 2. System performance test data

Service quantity	Library management system based on web platform		Library management system based on mobile AR		Book management system based on WeChat platform database	
	Response time/ms	Error rate of book recommendation/%	Response time/ms	Error rate of book recommendation/%	Response time/ms	Error rate of book recommendation/%
100	197.3	2.8	219.4	6.6	313.4	20.1
200	223.9	3.5	235.3	11.3	357.3	19.8
300	239.4	4.2	269.8	7.4	371.8	8.3
500	242.7	4.3	282.9	16.5	427.6	14.8
800	250.6	3.8	331.7	12.1	463.3	10.4
1000	264.9	4.2	361.6	6.9	526.9	12.7
1500	296.1	3.6	458.1	7.8	600.5	16.4

By analyzing the data in Table 2, we can see that the system in this paper can still keep the response time less than 300 ms in the face of high concurrent requests. The response time of the system is obviously shorter than that of the other two comparison systems, which indicates that the system in this paper has a good response performance under pressure test. Judging from the error rate of book recommendation, the error rate of personalized recommendation of books to different users in this system is less

than 5%, which indicates that it is more accurate and efficient to recommend books to system users. To sum up, the digital management system of library books based on web platform designed in this paper improves the efficiency and effect of book management, and can meet the demand of university teachers and students for personalized service of library. This is because the method in this paper uses the B/S structure to build the system architecture, so that the response between modules is faster, and sets the resource allocation of virtual machines to prevent some virtual machines from occupying most of the load when there are no available resources, configures the resources for book resource scheduling under the application of web technology, uses the vector space model based on background and temporal to determine user interest, and updates the attenuation value of interest in time, To ensure that the system can achieve rapid and accurate recommendation and management of book resources.

5 Concluding Remarks

This paper designs a digital library book management system based on web platform, which can use the web platform to improve the management efficiency of books and the user's satisfaction with the system. The B/S structure is used to establish the system architecture, which makes the response speed between modules faster, and can set the resource allocation of virtual machines, avoiding that some virtual machines occupy a large number of resources due to insufficient resources. The adjustment of book resources is configured using web technology, and the vector space model based on background and temporal is used to judge the user's interest, and the change of interest is updated in time, This ensures that the system can quickly and accurately recommend and manage book resources. The system test results show that the running performance and functions of the system meet the needs of digital management of books in university libraries, and the actual performance test results are better than the current book system.

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